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Voltammetric determination of β-carotene in raw vegetables and berries in Triton X100 media

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Electrochemical behavior of β-carotene in polar organic media and solubilized systems has been investigated. β-Carotene is irreversibly oxidized at 500 and 920 mV on glassy carbon electrode in 0.1 M $LiClO_4$ ethanol containing 10% of CH_2Cl_2. Effect of surfactants (cationic, nonionic and anionic) on voltammetric characteristics of β-carotene oxidation has been evaluated. High concentrations of surfactants facilitate the electrooxidation of β-carotene independently of surfactant type. The increase of oxidation current by 7–11% has been obtained in the presence of nonionic surfactant. The best results have been observed in 10 mM Triton X100 media. The peak current showed a linear dependence with the β-carotene concentration over the range 10–380 μM. The calculated detection limit was 2.5 μM and the quantification limit was 8.3 μM. Liquid extraction of β-carotene with dichloromethane from raw vegetables and berries has been developed. Quantitative determination of β-carotene in real samples using cyclic voltammetry in Triton X100 media combined with preliminary extraction has been carried out. The results obtained are in good agreement with data of nutrient database for standard references.

1. Introduction

β-Carotene is one of the most important carotenoids and widely occurs in plants, algae and few fungi [1]. Being precursor of vitamin A, β-carotene is considered as its major source in the human diet [2]. β-Carotene contains 11 carbon–carbon double bonds in conjugation (Fig. 1) [3] and acts as free radical trap or antioxidant playing an important role in quenching of toxic radicals including reactive oxygen species and protection of tissues from damage [4].

The characteristic conjugated double bond system of β-carotene and other carotenoids provides a wide range of properties i.e. absorption at the violet end of the visible spectrum, electrochemical activity, etc. But on the other side, there are many problems in work and manipulation with carotenoids that are associated with their instability especially towards light, oxygen, heat, acid and alkaline conditions [5–7]. Each factor may cause the degradation, oxidation and/or the *trans–cis* isomerization of β-carotene.

Different types of chromatography have been applied for the determination of β-carotene in real samples including high performance liquid chromatography (HPLC) with UV-detection [8,9], reversed-phase high pressure liquid chromatography [10], liquid chromatography with a coulometric electrochemical array detector [11] and normal-phase HPLC method [12]. The main advantages of chromatography are high versatility, sensitivity and selectivity providing reliable analysis of food samples.

The optic properties of β-carotene provide simple and cheap possibilities for its direct analytical determinations using near-infrared reflectance [13], xenon flash spectrometry [14] as well as resonance Raman and NMR spectroscopy, circular dichroism and mass spectrometry [15].

A simple spectrophotometric method has been developed for the quantitative analysis of total β-carotene in food additives such as powders, emulsions, and oily suspensions containing *E*/*Z*-isomers of β-carotene in different ratios. The approach is based on preliminary extraction with dichloromethane and ethanol and further measurement of the extracts absorbance at 421.0 nm [16].

The most important peculiarities of techniques applied to analyses of carotenoids including β-carotene and their impact on the reliability of the analytical results are discussed in review [17].

Although presence of conjugated double bonds in the structure of β-carotene provides its electrochemical activity, the analytical use of voltammetric oxidation and/or reduction processes, known to occur on the electrode surfaces [18], is rather limited. The amperometric detection of β-carotene in irradiated fruits after chromatographic separation has been described in [19]. HPLC with electrochemical detection has been developed for the determination of β-carotene in human plasma, blood cells and buccal mucosal cells [20]. Differential-pulse voltammetry on mercury

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